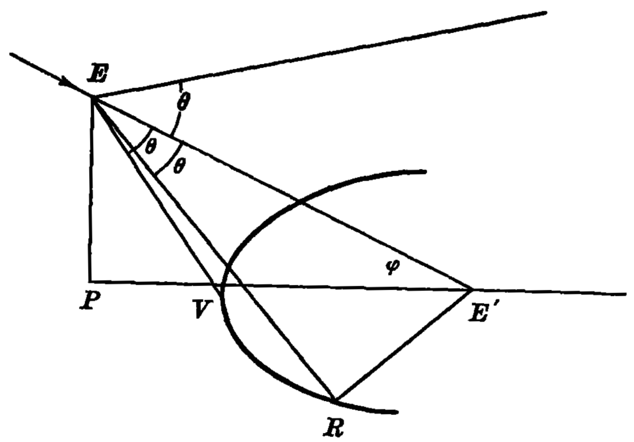

FIG. 4.

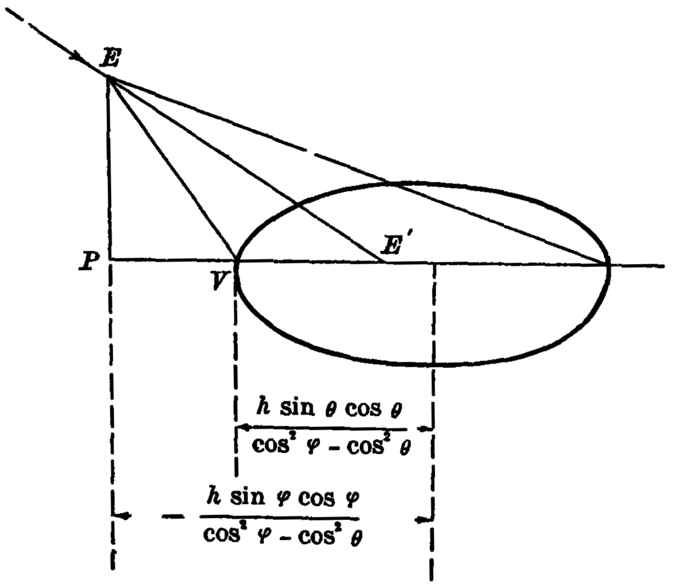

FIG. 5.

8. When the rainbow appears in the sky the air must be still and the space between the observer and the rainbow must be clear from any thick cloud or falling rain, so that the raindrops causing the rainbow fall in a vertical plane and the effective rays from these drops generate the surface of a cone having its vertex at the observer's eye and its axis parallel to the incident rays. Hence it is probable that the sky rainbow is, in general, elliptic in form though it may appear as circular.

To confirm this statement experimentally proceed as follows: When the sun shines from behind you in a laboratory, let your assistant stand at your arm's length and let him spray water drops in a vertical plane perpendicular to your line of sight. You will see a nearly complete elliptic rainbow whose major axis is vertical.

Hence the constancy of the angle between the incident and effective rays gives no more conclusive reason why the rainbow must be a circle.

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IMPROVED KITE HYGROMETER AND ITS RECORDS.

By WILLIS RAY GREGG, Meteorologist.

[Division of Aerological Investigations, U. S. Weather Bureau, Apr. 24, 1917.]

Free-air records of relative humidity are obtained by means of the hair hygrometer. In the Marvin kite meteorograph [1] the bundle of hairs is mounted longitudinally in the horizontal screening tube, which also contains the temperature element and recently the anemometer wheel. The meteorograph is attached to the middle back rib of the kite, just behind the front cell, in such a manner that the wind always blows directly through the screening tube, thus insuring good ventilation. In spite of its good exposure, considerable difficulty has always been experienced in obtaining accurate values of humidity, because of sluggishness or "lag" in the hygrometer. Part of this trouble has been eliminated by connecting the element as directly as possible

[1] See photographs published in this REVIEW, October, 1899, Pl. I; in Bulletin, Mount, Weather Observatory, v. 1, pt. 1, Pl. I; also Weather Bureau Bulletin F (Washington 1899), fig. 1 and fig. 5.—C. A., jr.

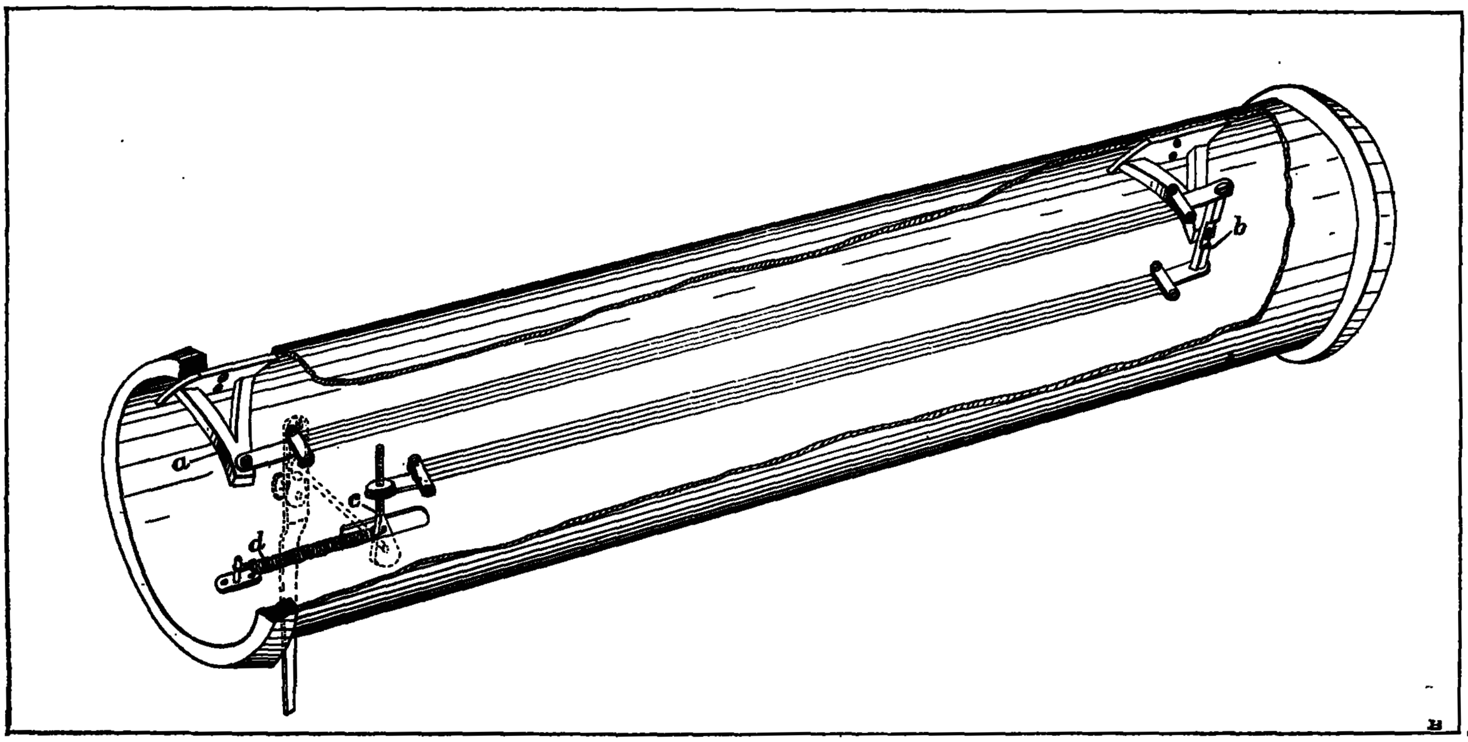

FIG. 1.—Section of horizontal screening tube in kite meteorograph, showing method of mounting hairs of hygrometer. *a*, Fixed post; *b*, Pivoted arm; *c*, Pen arm; *d*, Spring for holding hairs at constant tension.

with the recording pen, thus reducing to a minimum the lost motion in the mechanical bearings. Another radical improvement, introduced by Prof. William R. Blair in 1912, consists in mounting the individual hairs separately instead of in a bundle, as formerly. This new mounting is shown in figure 1. Two sets of hairs are used—one running from the fixed post at *a* to a pivoted arm at *b;* the other, from this point *b* to the pen arm at *c*. A small spring at *d* keeps the hairs at a constant tension. Thus any change in the length of the hairs is at once communicated to the recording pen. Small clamp nuts at *c* enable one to adjust the element so as to keep the pen from moving over too great a space on the meteorograph sheet for a certain change in humidity. Before mounting the hairs they are subjected to the same conditions of temperature and humidity and to the same tension, and are then fastened firmly with shellac. It has been found that the hairs, when thus mounted, respond very quickly to changes in humidity, whereas, when arranged in a bundle they require a relatively long time to change from dry to wet conditions and especially from wet to dry.

Notwithstanding these improvements, scale values determined in tests have frequently failed to agree with those indicated, at the beginnings and endings of free-air records, by the meteorograph traces, for which values of relative humidity were determined by means of a psychrometer. In making these tests the meteorographs were placed in a fairly tight wooden box, in which different humidities were successively produced by means of calcium chloride and blotters soaked with water. An Assmann aspiration psychrometer[2] was used in determining the relative humidity, and was read through a glass window in one of the sides of the box. A fan inside the box kept the instruments well ventilated. By this method a large range in humidity was obtained. Usually we made several such tests for each instrument, and the resulting mean scale values were used in the reduction of free-air records. These scale values worked very well for indicated humidities well within the range of the tests, but, in the case of records for which the pen indicated very high or very low humidities, they would often fail entirely to give reasonable values. Occasionally the computed relative humidity would be found to be considerably less than 100 per cent, when other evidence indicated that it should have been 100 per cent and, on the other hand, values below 0 per cent were sometimes indicated. During 1916, therefore, an effort has beeen made to determine the cause of these discrepancies and, if possible, to work out a scheme whereby more nearly accurate values could be obtained.

In several tests during the past few months at Drexel Aerological Station and at the central office—on Marvin meteorographs Nos. 18 and 575, the individual instruments regularly used in kite flights—scale values have been determined at low, intermediate, and high humidities. These tests were made in a manner similar to those formerly made, but over much smaller ranges in humidity. In addition, all free-air records obtained with these instruments have been examined and the scale values, indicated by the change in humidity from the beginning to the ending of the flight, i. e., at the times of base line readings, while the meteorograph was exposed in a shelter with a standard psychrometer, have been compared with the scale values indicated by the tests. In all cases the scale values have been considered in connection with the mean values of the humidities on which they were based. These scale values were then arranged in the groups of mean relative humidities 20–29, 30–39, etc. These values are given in Table 1.

[2] This instrument is described and illustrated in Milham's "Meteorology," New York, 1912. pp. 70-71.—C. A., jr.

TABLE 1.—*Humidity scale values of Marvin meteorographs Nos. 18 and 575.*

Mean humidities.	No. 18.		No. 575.	
	Number of observations.	Scale values.	Number of observations.	Scale values.
Per cent.		*Per cent.*		*Per cent.*
20-29	7	1.03	....	....
30-39	12	1.14	11	0.71
40-49	20	1.29	21	.77
50-59	27	1.34	38	.85
60-69	28	1.49	38	.93
70-79	20	1.52	32	1.01
80-89	7	1.64	....	....

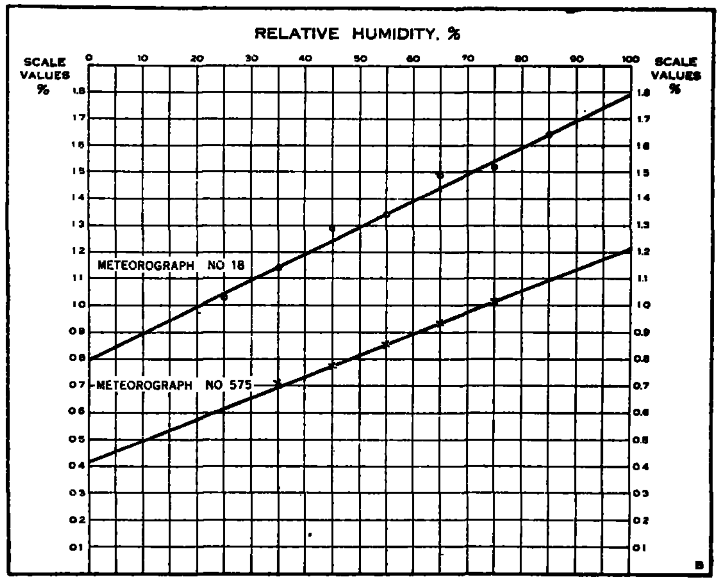

FIG. 2.—Curves showing humidity scale values for Marvin meteorographs Nos. 18 and 575.

Although the individual variations from these means are fairly large, the means themselves, when platted, as in figure 2, give very nearly straight lines, indicating uniformly increasing scale values for increasing humidities. In accordance with a suggestion by Mr. V. E. Jakl, of the Drexel Aerological Station, scales based on these curves have been constructed: One, shown by figure 3, is merely a measuring scale whose large divisions, 0 to 1, 1 to 2, etc., correspond to the divisions on the meteorograph sheet. The other is a scale of percentages which is constructed anew for each instrument, and figure 4 shows this scale for meteorograph No 18. In establishing a base or reference line, the zero point of the measuring scale is placed opposite the observed humidity on the percentage scale, and the base line value for any selected line on the meteorograph sheet is then read off directly. The base-line value adopted is the mean of the values at the beginning and at the end of the flight. In computing humidities at various levels, the zero point of the measuring scale is placed opposite the base line value on the percentage scale, and the humidity corresponding to any ordinate on the record is obtained from the percentage scale.

There are so many possibilities for errors in humidity observation and reduction that it is not thought that these scales will give absolutely correct values in all cases, but, in the reduction of records thus far obtained, they have indicated more consistent results than any method heretofore used.

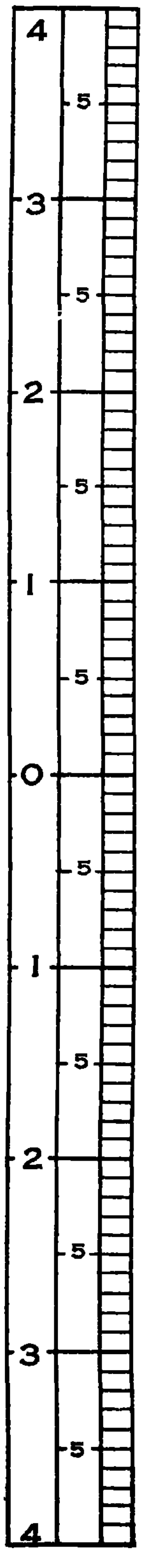

FIG. 3.—Measuring scale: Large divisions correspond to divisions on meteorograph record sheet.

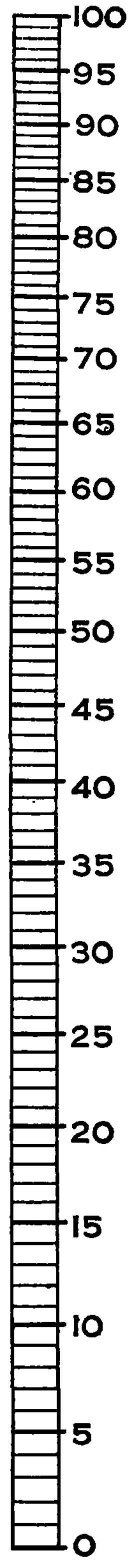

FIG. 4.—Percentage scale, used with scale in figure 4, for determining values of relative humidity for any ordinate on meteorograph sheet from No. 18.